

**GAS-PHASE NUCLEATION AND GROWTH OF SINGLE-WALL
CARBON NANOTUBES FROM HIGH PRESSURE CO**

5 ABSTRACT OF THE DISCLOSURE

The present invention discloses the process of supplying high pressure (e.g., 30 atmospheres) CO that has been preheated (e.g., to about 1000°C) and a catalyst precursor gas (e.g., Fe(CO)₅) in CO that is kept below the catalyst precursor decomposition temperature to a mixing zone. In this mixing zone, the catalyst precursor is rapidly heated

10 to a temperature that results in (1) precursor decomposition, (2) formation of active catalyst metal atom clusters of the appropriate size, and (3) favorable growth of SWNTs on the catalyst clusters. Preferably a catalyst cluster nucleation agency is employed to enable rapid reaction of the catalyst precursor gas to form many small, active catalyst particles instead of a few large, inactive ones. Such nucleation agencies can include

15 auxiliary metal precursors that cluster more rapidly than the primary catalyst, or through provision of additional energy inputs (e.g., from a pulsed or CW laser) directed precisely at the region where cluster formation is desired. Under these conditions SWNTs nucleate and grow according to the Boudouard reaction. The SWNTs thus formed may be recovered directly or passed through a growth and annealing zone maintained at an

20 elevated temperature (e.g., 1000°C) in which tubes may continue to grow and coalesce into ropes.